

OK TO ENTER: /W.Z./

03/23/2009

Application Number 10/789322

Response to Office Action dated 11/07/2008

RECEIVED
CENTRAL FAX CENTER

MAR 06 2009

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

1. (Previously Presented) A method of manufacturing a billet for cold forging, comprising:
 - a first spheroidizing annealing step of spheroidizing a carbide in a blank comprising ferrite and pearlite, wherein the pearlite is spheroidized;
 - a drawing step of drawing the blank at a predetermined drawing ratio after the first spheroidizing annealing step, wherein said drawing ratio is approximately 20%; and
 - a second spheroidizing annealing step of promoting the dispersion of the internal carbide to increase spheroidizing ratio after the drawing step.
2. (Cancelled)
3. (Previously Presented) The method according to claim 1, further comprising a cutting step of cutting said blank to a desired dimension, wherein the cutting step is between said first spheroidizing annealing step and said second spheroidizing annealing step.
4. (Previously Presented) The method according to claim 1, wherein said blank is composed of 0.46-0.48 wt% of C (carbon), 0.14 or less of Si (silicon), 0.55-0.65 wt% of Mn (manganese), 0.015 wt% or less of P (phosphorus), 0.015 wt% or less of S (sulfur), 0.15 wt% or less of Cu (copper), 0.20 wt% or less of Ni (nickel) and 0.35 wt% or less of Cr (chromium).
5. (Previously Presented) A method of manufacturing a billet for cold forging, comprising steps of:
 - quenching a blank unloaded from a heating furnace to form a fine martensitic structure in a surface thereof, an intermediate layer comprising martensite, ferrite, and pearlite formed

Application Number 10/789322
Response to Office Action dated 11/07/2008

radially inwardly on the surface, and a central region comprising a mixed phase of ferrite and pearlite,

annealing the blank to convert the martensitic structure of the surface and the intermediate layer into a fine spheroidized structure comprising ferrite and cementite, and breaking the pearlite of the intermediate layer and the central region, and then

obtaining the surface with the fine spheroidized structure comprising ferrite and cementite, the intermediate layer comprising a mixed structure of the broken pearlite and the fine spheroidized structure comprising ferrite and cementite, and the central region comprising broken pearlite.

6. (Previously Presented) The method according to claim 5, wherein annealing said blank is by holding the blank at about 740°C for six hours, thereafter dropping the temperature to about 680°C at a rate of 20° C/h, and thereafter cooling the blank in a furnace.

7. (Previously Presented) The method according to claim 5, wherein annealing said blank is by holding the blank at about 750°C for 4 hours, then at about 735°C for 3.5 hours, thereafter dropping the temperature to about 680°C at a rate of 15° C/h, and thereafter cooling the blank in the furnace.

8. (Previously Presented) The method according to claim 5, wherein said blank is made of a carbon steel which is composed of 0.46-0.48 wt % of C (carbon), 0.14 or less of Si (silicon), 0.55-0.65 wt% of Mn (manganese), 0.015 wt% or less of P (phosphorus), 0.015 wt% or less of S (sulfur), 0.15 wt% or less of Cu (copper), 0.20 wt% or less of Ni (nickel), 0.35 wt% or less of Cr (chromium), and a remainder of Fe (iron) and impurities.

9. (Previously Presented) The method of cold-forging a billet manufactured by a method according to claim 5, wherein steps of cold-forging the billet include continuously drawing the billet, upsetting the billet, and finishing the billet without softening the billet in an intermediate stage.

Application Number 10/789322

Response to Office Action dated 11/07/2008

10. (Withdrawn) A crankshaft comprising a billet manufactured in accordance with the method of claim 1.
11. (Withdrawn) A crankshaft comprising a billet manufactured in accordance with the method of claim 5.
12. (Withdrawn) A method of cold-forging a crankshaft from a billet formed by continuous cold forging, wherein the first step of extruding the billet to form a multi-stepped shaft having at least two steps and contiguous to a main body, the second step of upsetting and drawing the formed work piece to simultaneously increase the diameter of the main body and reduce the diameter of at least a portion of the multi-stepped shaft, the third step of upsetting and drawing the formed work piece to simultaneously rough the main body to an asymmetrical shape and reduce the diameter of at least a portion of the multi-stepped shaft, the forth step of pressing an asymmetrical boundary of the main body to simultaneously finish the main body and form a central hole axially centrally in the main body, and the fifth step of forming a pin hole in the main body at a predetermined position and removing an outer circumferential portion of the main body thereby to shape the main body.
13. (Withdrawn) A method according to claim 12, wherein splines are formed on an end of said multi-stepped shaft in said fourth step.
14. (Withdrawn) A method of cold-forging a disk-shaped apart with a shaft from a multi-stepped intermediate blank through a plurality of forging steps, characterized by forming an asymmetrical disk having a left and right portions of different volumes with respect to an axial center of said intermediate blank.
15. (Withdrawn) A method according to claim 14, wherein the ratio of the volumes of the left and right portions of said disk is about 1:2.

Application Number 10/789322
Response to Office Action dated 11/07/2008.

16. (Withdrawn) A method according to claim 14, wherein in order to achieve the different volumes, inclined surfaces having different angles of inclination are formed across a junction between the left and right portions which extends from the shaft of the blank to the disk.

17. (Withdrawn) A method according to claim 16, wherein the angle of inclination of the portion having the greater volume is smaller than the angle of inclination of the portion having the smaller volume.

18. (Cancelled)

19. (Currently Amended) A method of cold-forging a crankshaft comprising:

a first spheroidizing annealing step of spheroidizing a blank made of a carbon steel which is composed of 0.46-0.48 wt% of C (carbon), 0.14 or less of Si (silicon), 0.55-0.65 wt% of Mn (manganese), 0.015 wt% or less of P (phosphorus), 0.015 wt% or less of S (sulfur), 0.15 wt% or less of Cu (copper), 0.20 wt% or less of Ni (nickel), 0.35 wt% or less of Cr (chromium), and a remainder of Fe (iron) and impurities,

wherein the carbon steel includes a ferrite and a pearlite,

wherein in the first spheroidizing annealing step, the pearlite is spheroidized;

a drawing step of drawing the blank at a predetermined drawing ratio after the first spheroidizing annealing step, wherein said drawing ratio is approximately 20%;

a second spheroidizing annealing step of promoting the dispersion of an internal carbide to an increased spheroidizing ratio after the drawing step thereby to produce a billet;

a cold-forming step of continuously cold-forming the billet into a crankshaft;

an aging step of aging the crankshaft; and thereafter

a cooling step of cooling the crankshaft to normal temperature.

20. (Cancelled)

21. (Withdrawn) A method of cold-forging a disk-shaped part with a shaft, characterized by holding the shaft of the cold-forged disk-shaped part with a lower support base of a forming die, lowering an upper die assembly to hold the disk of the disk-shaped part between the lower

Application Number 10/789322
Response to Office Action dated 11/07/2008

support base and an upper support base and lower the disk-shaped part by a predetermined stroke, punching a hole in a predetermined region of the disk with a punch of a lower die assembly, and thereafter lowering the upper die assembly to cause an upper die to remove an outer circumferential portion of the disk.

22. (Withdrawn) A method according to claim 21, wherein accommodating a scrap removed by the punch in a receptacle in the upper support base, holding a scrap removed by the upper die between the lower die assembly and the upper die, and thereafter, when the upper die assembly is lifted, placing the scraps into original positions thereof in the disk, and discharging the scraps when the disk-shaped part is ejected.

23. (Cancelled)